CANADIAN ARCHITECT AND BUILDER.

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—THE—

CANADIAN ARCHITECT AND BUILDER,

A Monthly Journal of Modern Constructive Methods,

(With a Weekly Intermediate Edition—The CANADIAN CONTRACT RECORD),

PUBLISHED ON THE THIRD SATURDAY IN EACH MONTH IN THE INTEREST OF

ARCHITECTS, CIVIL AND SANITARY ENGINEERS, PLUMBERS, DECORATORS, BUILDERS, CONTRACTORS, AND MANUFACTURERS OF AND DEALERS IN BUILDING MATERIALS AND APPLIANCES.

C. H. MORTIMER, Publisher,

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SUBSCRIPTIONS.

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ADVERTISEMENTS.

Prices for advertising sent promptly on application. Orders for advertising should reach the office of publication not later than the 12th day of the month, and changes of advertisements not later than the 5th day of the month.

EDITOR'S ANNOUNCEMENTS.

Contributions of technical value to the persons in whose interests this journal is published, are cordially invited. Subscribers are also requested to forward newspaper clippings or written items of interest from their respective localities.

The "Canadian Architect and Builder" is the official paper of the Architectural Associations of Ontario and Quebec.

The publisher desires to ensure the regular and prompt delivery of this Journal to every subscriber, and requests that any cause of complaint in this particular be reported at once to the office of publication. Subscribers who may change their address should also give prompt notice of same, and in doing so, should give both the old and new address.

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THE painters' strike at Winnipeg, referred to in our last issue, is ended. The strikers haue returned to work at the old rate of wages.

THE United States Customs regulations require that to each invoice of granite exported to the States, there must be attached a diagram of each piece so exported and a sworn statement of the value. Enquiries are being made at Ottawa with the view to ascertain what method is employed by Canadian Customs officials to ascertain the value of manufactured granite exported by Great Britain and the United States to Canada.

THE brick manufacturers in Toronto and vicinity have organized an association, and have decided to reduce the scale of wages paid to employés. This action has been promptly followed by the organization of a brickmakers' union, and a determination on the part of the employés to submit to no reduction. The surplus stocks on hand are so large, and the building outlook so unpromising, that some of the manufacturers decided a month or two ago not to operate their yards this season. Under these circumstances, the probabilities are decidedly adverse to any satisfactory results being obtained from a strike of employés at this time.

AN effort will be made at the next session of the Ontario Legislature to have the Mechanics' Lien Act amended in several important particulars. At a recent meeting of representatives of the Toronto Builders' Exchange, Trades and Labor Council, and material supply men of Toronto, this subject underwent discussion. A committee was appointed to draft required amendments to this Act and submit the same for consideration at a future meeting. The discussion brought out the fact that the lien law of Ontario affords less protection to mechanics and persons supplying materials, than laws existing for the same object in many of the States of the Union.

THE Toronto Architectural Sketch Club might profitably follow the custom of English Architectural Societies in visiting in a body as frequently as possible during each summer buildings in course of erection, previously arranging with the architects of the building to be present to explain the points of interest connected with the construction. It is safe to say that one such visit may be the means of affording students more practical instruction than could be obtained from half a dozen lectures. A visit of this character was made to the Hospital for Sick Children on College street, and proved to be of great interest and value. It is to be hoped that a series of similar visits will be arranged for the present summer.

REFERENCE has often been made to the unfairness and sometimes the absurdness of the conditions of architectural competitions. The evil has possibly reached its limit so far as its effects upon architects is concerned. It seems, however, to be now trying to find its way into the engineering profession. The following advertisement recently appeared in the daily papers: "The town of——contemplates the construction of waterworks this year, and invites tenders, to be opened 30th inst. Those tendering to furnish their own plans and specifications at their own expense. The lowest or any tender not necessarily accepted. For particulars communicate with——." The above is so palpably a case of "heads I win, tails you lose," that we may presume no engineer will be so foolish as to enter the game.

THE question as to who shall fill the position of City Clerk of Montreal, has not at the time of going to press been absolutely decided, but there is very little doubt that Mr. L. O. David will be Mr. Glackmeyer's successor. He was nominated by the Finance Committee, and in all probability the matter will be decided at the next meeting of the Council. Mr. L. O. David is by no means an unknown man. He has been a prominent figure before the Montreal public for many years, having occupied platform after platform in the interests of the French-Canadian element of the population of the Dominion. He has not heretofore occupied any civic position, but his recommendation by the Finance Committee augrs well for his success in a post of such importance as that of City Clerk of Montreal.

IN response to a number of requests, we have decided to publish in the CANADIAN ARCHITECT AND BUILDER for June, the examination papers in connection with the first O. A. A. students' examinations. In this number we present reproductions of a couple of the drawings submitted in these examinations, which will serve to indicate to students taking part in future examinations the character their drawings should assume.

THE Toronto Builders' Exchange is desirous of making some arrangement with the architects which will serve to avoid the delays at present experienced by contractor in obtaining certificates. A contractor who may be doing work for several architects, sometimes finds it impossible to get around to their offices and secure his certificates on certificate day, on account of being obliged to wait his turn in each office. It is suggested that this inconvenience could be avoided by the contractors notifying the architect of his desire to obtain a certificate for a stated amount previous to certificate day, when the certificate could be filled out ready to be handed to him when he might call.

THE Toronto Builders' Exchange, an account of the formation and objects of which was published in our April number, is making satisfactory progress. The membership has increased to such a degree that it has been found necessary to remove to more commodious quarters. These have been secured in the new premises now being fitted up at the corner of Victoria and King streets. The Exchange will take possession of its new home on or about the first of June, and will then have, in addition to a large exchange room, necessary committee rooms and secretary's offices. Mr. John Phillips has been appointed Secretary of the Exchange. It is believed the appointment will prove to be satisfactory. It has been decided to abolish the two classes of membership heretofore existing, and hereafter to allow all members to occupy the same footing. From the fact that during the past month further applications for information have been received from other cities desirous of forming exchanges, it would seem probable that the organization of the building interests throughout the country will be an event of the near future.

RECENT advices from Vancouver, B. C., point to indications of a busy season for the building trades. The unsettled conditions existing between contractors and mechanics, however, are said to be proving a check upon activity. Some of the contractors are reported to be desirous of increasing the working day from nine to ten hours, while others, rather than provoke trouble with the unions, are willing to pay union wages for a nine hours day. The employers very justly complain of the practice of the unions in demanding increases in the rate of wages without giving due notice which would enable them to embody in their estimates the increased cost of labor. These demands for higher wages are most frequently made after contractors have undertaken a large amount of work, the estimates for which have been based upon the prevailing labor prices. The contractors feel, so long as this unfair treatment is accorded to them by the unions, that they are justified in endeavoring to secure workmen from Eastern Canada and elsewhere, even though by so doing the local labor market should become overstocked. An effort should be made to come to an understanding, as is done in Toronto and other eastern cities, under which the rate of wages in the several trades would be fixed for a period of three or five years. Thus the conditions affecting employés, employers and investors would be settled for a definite period.

THE result of the examinations of the Ontario Society of Architects is in every way very satisfactory. They were held too late for us to give the results in our last issue, the reports of the examiners not being in. Since then the Board of Examiners has held its final meeting, made its reports to the Council, and the results have been made public to a certain extent, in the daily press. For our part we are glad to place on record in our columns the names of those who successfully passed the final examination, which we do in alphabetical order: Baxter, D. G.; Bayley, G. M.; Bond, C. H. A.; Brown, J. F.; Gregg, A. H.; Hynes, J. P.; Langley, C. E.; Matthews, H. E.; McCallum, R. J; Munro, W. L.; Smith, Eden, White, M. A.; Woolnough, J. J. The candidates, whether successful or not, have not been allowed, we understand, to know their marks. The examinations have been throughout conducted on the lines of the University examinations, where the marks are known only to the Board of Examiners. On the whole, the passing of thirteen out of nineteen is a very good proportion, and while we wish our new architects every success in the future, we would say to those who failed that there is no reason for discouragement on their part. In many cases to be plucked once is an advantage, and those who were plucked will no doubt set to work earnestly and prepare for a second attack, having found out their weak points. In the second intermediate, nine students passed out of twelve, and in the first intermediate, two out of four. There is to be a supplementary examination some time in September for the benefit of a few candidates in the first and second intermediate classes, whose work at the recent examinations, though not up to the standard, was fairly good, and these will be allowed another chance, that they may be able to take up another stage of examination in the following spring. This advantageous practice of a supplementary examination has a precedent in the procedure of most professional institutions.

TORONTO ARCHITECTURAL SKETCH CLUB.

THE second annual dinner of the Club, held at Webb's, on the evening of April 19th, was the occasion of much enjoyment. In addition to members of the Club, there were present the President and, Registrar and Messrs. Burke, Wickson, Gregg, Darling, Gordon, Bousfield, Simpson, Jarvis and Sproatt, of the Ontario Association of Architects. The School of Practical Science was represented by Mr. Wright, lecturer on architecture, and the contracting interests by a number of persons prominently identified with the various trades.

Mr. J. A. Pearson, President of the Club, presided.

The menu card was an unique affair, and occasioned much amusement. It read as follows:

THE TORONTO
ARCHITECTURAL
SKETCH
CLUB

Specification of work to be done and material to be supplied and consumed in renewing the dilapidated condition of the students caused by the drainage system of the late examinations.

CONTRACTOR
HARRY WEBB

ALL MEMBERS TO
COME IN
SPRUCE TIES, COLLARS,
BRACES, AND
CAST IRON SHOES.

SOUP
OYSTER SOUP, to be carefully lapped
FISH
BOILED LAKE TROUT with herring bone bridging
ANCHOVY SAUCE
POMMES PARISEINNE
BREAD AND BUTTER ridge ROLLS
ENTREES
CHICKEN PATTIES composed of stopcocks, bibcocks, and weathercocks
JOINTS
To be bolted
All carving to be done in an artistic manner
FILLED AND B OILED TURKEY
Well rubbed down under each coat
ROAST BEEF quarter cut, HORSERADISH SAUCE
BROWN POTATOES (Cabot's stain),
YORKSHIRE PUDDING,
All inside work to be well flushed up after each course
VEGETABLES
To be filled in and well rammed down in layers not more than 12 inches deep
MASHED POTATOES and STEWED TOMATOES.
ENTREMETS
PLUM PUDDING mixed in proper proportions and stored up at least six months before using.
BRANDY SAUCE.
CHARLOTTE RUSSE with jamb linings APPLE PIE
LEMON MERINGUE PIE CELERY CHEESE
SWEETS
NEAPOLITAN ICE CREAM classic frieze
HARD BURNED CAKES assorted sizes and uniform color
RAISINS and FIGS up to DATE um line
FRUITS
APPLES ORANGES BANANAS
Nuts and Washers as follows
LEMONADE and COFFEE
The whole of the work on completion to be subjected to a smoke test.

The specification was declared to be a most complete and satisfactory one, all cheerfully complying with its conditions. It was observed that perhaps its most unorthodox feature was the provision made for extras. The carrying out o. this specification was followed by an interesting programme of speeches and music.

Responding to the toast of "The O. A. A.," the President, Mr. S. G. Curry, referred to the recent student's examinations. Though not resulting as satisfactorily as might have been desired, yet considering that both students and examiners were without previous experience, they should be regarded as having been on the whole fairly satisfactory, and the knowledge gained would afford a basis for improvement in the future. One beneficial result of such examinations was that they served to direct the study of students in the proper direction. He felt assured that a feeling of timidity prevented many students at the late examinations from doing their best. Many absurd answers would have been avoided if the students had been careful to clearly understand the meaning of the questions. As an example of some of the absurd answers given, a student on being asked for a common test for finding impurity in air replied: "Climb upon the roof and put peppermint down the soil pipe." (Laughter). Another student who was asked what would be a

safe load to impose on ordinary clay soil, said : "A frame one or two storey house, or load up to 837 tons." Such answers he believed to be due, as already stated, to lack of proper consideration of the questions. These features of the examinations would doubtless in time disappear. At first it was thought the examinations might be concluded within two days, but it was found necessary to double the period. Even four days was much too short a time. It was not right that students should be compelled to write on an examination for three or four consecutive days. There should be time allowed for rest and study. Two weeks would not be too long a period. The examinations had revealed the fact that students who were supposed to be well up in certain subjects, in reality knew very little about them The O. A. A. should feel grateful to the students who had come forward to assist it in carrying out its objects. The speaker pointed to the fact that an Act was in a fair way to be passed by the New York Legislature under which no man would be able to call himself an architect without having obtained a license to practice in the State. At the next session of the Legislature the O. A. A. should endeavor to have the word "Registered" struck out of the Architects' Act, and by so doing secure a guarantee to the public that persons practicing architecture were competent to do so. The speaker concluded by expressing the hope that the members of the Architectural Sketch Club might be better able than the architects of the present day to do meritorious work.

In response to the toast "Canadian Architecture," Mr. Langton spoke as follows :

People who live in the older countries have inherited the results of the labor of many generations. They live as it were in a completed edifice and enjoy all its comfort and beauty, and, though in some respects life is therefore so much the less worth living, it cannot be denied that there is great pleasure and privilege in being posterity.

We, on the contrary, are ancestors. We are the early Canadians hard at work upon the foundations. We are not cribbed and cabined and confined like our kin beyond the sea, but, on the other hand the glories of our buildings are all in the future. Canadian architecture is rather a subject for speculation than criticism ; we may say that Canadian architecture as an established fact as yet does not exist.

There has been much said during the last half century in England about the formation of a modern style. More recently in the United States there has been talk about an American style It was hoped that the late H. H. Richardson had created a style that would become national. It may be true what was said by an English reviewer, that since the architect of the Palace of Diocletian generated Romanesque architecture by taking the column of the Roman order and inserting it under the arch, no one man has done so much to develop a style of architecture as Mr. Richardson. Yet I think it has proved to be a mistake to found on his work the hope of an American style. The school of imitators are one by one turning their attention in another direction. The mark that Mr. Richardson has left upon American architecture is something much wider and deeper than the mere appropriation of the peculiar characteristics of one particular period of architecture. He taught us how to make use of the examples left us from former times by catching from them the spirit of the workman and doing our own work in the same spirit. He did no copying. What he took from an old example was not only adapted but usually improved. In the case of the most salient example of his reproduction of a model—that of the tower of Trinity church—I think we may fairly say that we should have heard very little of Salamanca Cathedral if the tower of Trinity Church had not been built to put honor upon the tower of Salamanca as the original.

I think then we may agree that the Richardsonian Romanesque revival had as much vitality in it as it is possible for a style revival ever to have. Not only was the style adopted made to live in our century but there seemed to be something in the theoretical view taken by approving critics that, inasmuch as the style adopted was an undeveloped style, there was the more hope that the natural law of development should have course with it now that it was revived.

However, the course of work in the United States seems to be moving away from it, retaining only the high standard of taste and the right feeling in design which were introduced into the country along with it, and which I think we may hope are part of the inheritance of American architects and of ourselves henceforth. The right spirit is abroad, and though the architectural world seems to one living in it to be a wild sea of conflicting determinations and shifting views, I think one who has even a slight acquaintance with history will recognize the condition from which have emerged all those results which have formed steps in the world's advance, from which succeeding generations take their start, and to which they always return for their basis. I think we may almost consider that the word style—though in an old country like England, where tradition has force, and where they are empowered by the excellence of the past, still retains its conventional usage as applied to architecture—may with us on this continent begin to have the deeper and better meaning of character, which includes the other and goes beyond it.

To say that a man or a woman has style, is to give to them the highest expression of admiration for their personal charm. Style is beyond beauty, though it often includes it—always includes it in the highest sense of the term. It is the harmonious compound of qualities which makes the man or woman who possess it strike the eye at once, and impress us as distinct. This is what we want in architecture. Not fashion in architectural clothing, but that the building have always distinction of character in accordance with its own programme of requirement, and the conditions of its circumstances. It must be a growth proceeding from the continual effort to satisfy the conditions of our mode of life, our means, our climate, and our material. I doubt if anything can permanently prevent the growth of a true style of architecture, but it may be delayed by temporary fashion quite enough to prevent any of us having the pleasure of seeing it in our life-time. So I want to enlist your sympathy on the right side. You will be soon starting out for yourselves—some of you this year—and your services are wanted in this matter. It is the work of the many, and with a common idea we can progress fast, helping one another by example, as iron sharpeneth iron. The English House of Commons as a body is said to be always wiser than the wisest man in it, and we have no need to wait for the advent of a genius to create Canadian architecture, if we only have in common the idea of making our architecture true. It ought not to be necessary to say much upon this subject so long after the acceptance by the architectural world that in art only truth is life. But we have only to look about us to see that its application still lags.

We have still amphitheatrical churches with a couple of storeys of society rooms and class rooms, all contained within an exterior which represents as faithfully as it can the mediæval church with its single spacious hall. We are are about to have a drill shed here which, inasmuch as it is Government work and the result of tradition rather than individual intention, we need not feel shy of criticizing. It is, of course, to be a castellated structure. In former days arms were kept in a castle. Must, therefore, the building that stores our arms nowadays represent a castle, however feebly ? Are we to suppose that when Toronto is surrounded by the beleaguering host, our brave defenders will retire upon the impregnable drill shed and man the battlemented turrets and cornice ? We might as well hold that because our grandfathers travelled by means of horses, we should, therefore, build our railway stations to represent as far as possible a stable. I do not want to turn this into a lecture upon truth in architecture, only to take the stand that this only is the course along which our architecture can develop.

There was a little dialogue in this morning's *Mail* which seemed to me to offer a good illustration of the point.

It is as follows :

Artist—"Those evergreens on the north side of your house have a delightful effect."

Farmer—"I should say they had. Them trees keep off the wind and save about $8 worth o' firewood every winter."

That is the whole thing in the nutshell. The farmer plants a row of trees where they are wanted. The trees have a delightful effect. And the more you perceive the usefulness of the trees, the deeper the effect of poetry which they produce. Art and matter of fact are inseparable.

If architecture is to satisfy, the plan must be convenient, and must be expressed in the composition. The construction must be suitable to the kind of building, to the material, and to the climate. This a brief recipe which, however, means a great deal. And I appeal to you if it is not more manly and more worth the devotion of one's energies than always trying to get away from your own problem in imitation of something entirely different.

It takes thought, of course, but you will have at first, when you begin practice a great deal of what has been called "God-given leisure," in which you can invent at your will. You wlil find also that you know nothing. It will surprise you to find this. It did me. You will have to learn much then, and will have to teach yourselves : and you may as well learn the right way while you are about it. The problems of architecture are limited after all. You must ultimately be at home with them in one way or another. If you will get into the way of handling them rightly you wil l be better architects, you will be better men, and you will be happier men. You will not find work wearisome as you grow older, but will find in it an interest that mere money making cannot give. And Canada will have buildings that will give pleasure to those who see them, which foreigners will recognize as Canadian, intimately associated with the life of the country—the Canadian style of buildings.

Mr. W. H. Elliott, responding on behalf of the contractors, said the interests of no two classes could be more identical than those of the architect and contractor. In fact, so close was their relationship, that like cats thrown across a rope, they sometimes got to fighting—about what, the architects only know. (Laughter). One lack in relationship would be supplied if architects would refuse to allow contractors to work for less than a fair price. If this rule were adopted, a better class of buildings would be the result. Architects sometimes congratulated themselves upon having secured a low price for their work, but he desired to tell them, if unaware of the fact, that it was impossible to beat the contractor. (Laughter).

Mr A. H. Gregg claimed that the contraction caused by the recent exams, followed by the sudden expansion on the present occasion, left him in no fit condition to respond to the toast to "The Coming Architects." In no way was the world's progress better illustrated than by the facilities for education which were being placed before the rising generation. There was a general

attempt to elevate the standard of all the professions and callings. This extended even to the ranks of the anarchists, who recently placed a charge of dynamite under the School of Architecture at Madrid, but whose plans, like those of many other reformers, were frustrated and their enthusiasm dampened by a callous caretaker. (Laughter). The students were deeply grateful to those members of the O. A. A. who had so disinterestedly sought to promote their welfare. The speaker pointed to the need of a better appreciation of the profession of architecture on the part of the public, and even of persons otherwise refined, and mentioned the case of a lady who was desirous that her son should enter one of the professions, and who brought him to an architect's office, with the remark that as he was somewhat dedeficient in education she had decided that he should become an architect. The speaker remarked that if the public glance could have rested on the bundle of papers required to be dealt with by the students at the recent examinations, and which, notwithstanding, were but the first fragment of the knowledge to be acquired, they might conclude that some degree of erudition was necessary to the architect.

Some excellent songs were sung between the toasts by Messrs. J. Francis Brown, E. B. Jarvis, R. Wilson, J. J. Woolnough, Geo. Self and Mr. Thomes. Mr. Woolnough also gave a piano solo, and Mr. Jas. Newton some well executed selections on the violin. A couple of recitations were given in creditable style by the President.

The assembly dispersed soon after midnight, having spent a thoroughly enjoyable and profitable evening.

A CASE OF ILLICIT COMMISSION.

The Council of the Ontario Association of Architects desire the publication of the following letter which has come into their possession :

To A. B. C., Esq.,
Architect.

DEAR SIR,—I have been accustomed while working under architects in this city, as well as other places, to allow a commission to those who use their influence in my behalf, while letting contracts on alterations, repairs, etc., that they may have in hand. I intended to speak to you on this matter while in your office this afternoon, but failed to get you alone. I will be pleased to arrange matters between you and myself in this way, as I consider an architect and contractor can work together with profit to each other. The time has come when prices are so low that contractors require to scheme a little to come out square. My usual allowance has been five per cent. on all work and two and a half on all material. If these figures are worthy of any notice let us talk together. Yours truly,

———

Contractor.

It is this sort of thing the Association was originally designed expressly to prevent. The members of the Association are required to sign a declaration binding them to set their faces against iilicit commissions in their own practice, and now that the feeling of the profession has been actively enlisted in the matter, contractors who seek to "come out square" by this manner of proceeding will find, sooner or later, that it is not to their own advantage.

OUR ILLUSTRATIONS.

PHOTOGRAVURE PLATE—RESIDENCE OF MR. R. B. ROSS, MONTREAL, QUEBEC—BRUCE PRICE, ARCHITECT, NEW YORK.

RESIDENCE OF MR. E. A. WILLS, GWYNNE STREET, TORONTO—J. FRANCIS BROWN, AREHITECT, TORONTO.

From the grey sandstone foundation to the first storey window sills is built of red brick, laid in brown mortar, with Portage Entry sandstone trimmings ; above this is finished in half-timbered work, starting from a heavy plate bolted to brickwork. The half-timber framing is constructed of 2"x2" studs placed at 12" centres, framed and braced, boarded with wrought boarding, covered with saturated building felt, battened and lathed. The exterior framing is secured to interior framing ; the panels are plastered with cement mortar, constituted of cement and coarse sand, colored to harmonize with general color scheme. The interior is well finished in oak and pine. The rooms are spacious, well arranged and heated with hot water. The following contractors did the work : Carpenter and joiner's work, Davidson & Kelly ; masonry, T. Self ; plumbing, Fred. Armstrong ; plastering, F. Beaver ; painting and leadglazing, Faircloth Bros. galvanized ironwork, Tucker & Dillon ; hot water heating, the E. & C. Gurney Co.

BAPTIST CHAPEL, WALMER ROAD, TORONTO—LANGLEY & BURKE, ARCHITECTS, TORONTO.

O. A. A. EXAMINATION IN DESIGN—SKETCH FOR CHURCH SUBMITTED BY J. FRANCIS BROWN, TORONTO ; SKETCH FOR HOUSE SUBMITTED BY W. MUNRO, TORONTO.

We publish elsewhere a list of tests of the Thorold cement, which are claimed by the manufacturers to be the highest tests ever made of any Canadian natural cement.

CANADIAN CITY ENGINEERS.

VI.

Mr. F. W. W. DOANE, City Engineer of Halifax, Nova Scotia, was born at Barrington, Shelbourne Co., N. S., on May 31st, 1863, his father being Capt. Harvey Doane, well known in his native province.

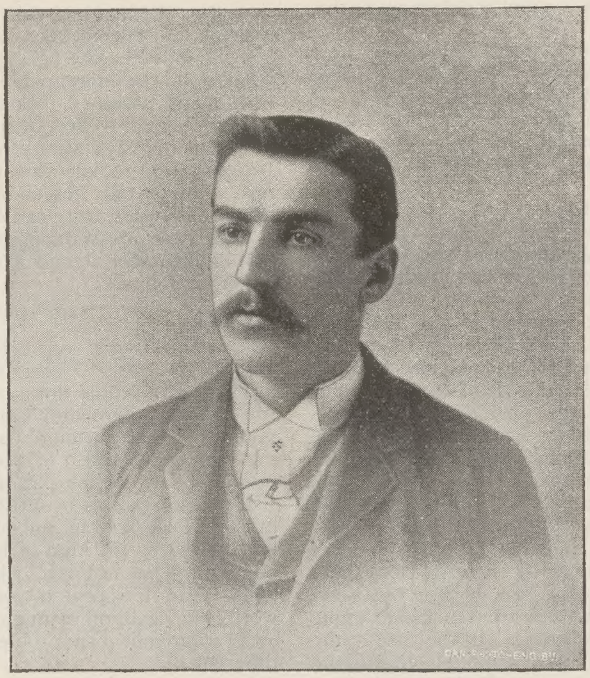
The subject of our sketch began engineering work in 1882. From 1883 to 1891 he was assistant to the provincial government engineer of Nova Scotia. During that time over $1,000,000 was expended on highway bridges. The work of the Department also included railway surveying and construction, water supply, sewerage, laying out, construction and repair of public roads, and reclamation of land from the sea. In 1886, Mr. Doane was sent out on the survey of the Musquodoboit Valley and Stewiacke Railway ; in 1889, on the Carleton Branch Railway and Western Shore Railway, and in 1890, on the Heatherton and Guysboro Railway and North Colchester Railway. In June, 1891, he was appointed City Engineer of Halifax, N. S. The duties embrace all kinds of city works, such as engineer and superintendent of water works, charge of public works, street grading, paving, repairs, &c., sewers, maintenance and repairs of city property, and all improvements.

Mr. Doane has recently recommended the construction of new sewers estimated to cost $75,000, and submitted a report to the City Council on a scheme for improvement in the city water supply. A new 27" main is to be laid, new dams and gate houses constructed, and storage capacity increased 275,000,000 gallons. The improvements are estimated to cost $200,000. There have also been inaugurated extensive street and sidewalk improvements, which it is expected will add greatly to the appearance and reputation of the city.

In co-operation with the Board of Health, the Engineer is thoroughly reforming the plumbing system and sanitary arrangements of the whole city (of which there was very urgent need).

Mr. Doane is probably the youngest member of the Canadian Society of Civil Engineers.

He has been a member of the Council of the Institute of Halifax since 1888, and is likewise a member of the Faculty of Pure and Applied Science of Dalhousie College and University, being lecturer on civil engineering and surveying.



MR. F. W. W. DOANE, CITY ENGINEER, HALIFAX, N. S.

ONTARIO ASSOCIATION OF ARCHITECTS.

The following is the official list of the results of the recent examinations :

Admitted to registration as members of the Association :—Messrs. D. G. Baxter, G. M. Bayly, C. H. Acton Bond, J. F. Brown, A. H. Gregg, J. P. Hynes, C. E. Langley, H. E. Matthews, R. J. McCallum, W. L. Munro, Eden Smith, M. A. White, and J. J. Woolnough. Conditioned—Messrs E. A. Bird, W. G. Burns, W. W. Pease.

Second intermediate examination : Passed—Messrs. F. P. Kelley, Wm. Rae, A. E. Wells. Conditioned—Messrs. Kenneth Gordon, T. R. Johnson, H. G. Macklin, R. B. McCiffen, J. V. Munro, Geo. M. Scott.

The supplemental examination for conditioned candidates will be held in next September.

It is not proposed in future years to admit candidates for the final examinations to a supplemental examination. On this occasion, as many of the students presenting themselves for the final examination have been obliged to wait for the instruction of the examinations, and so have served terms longer than required by the Association, the council has appointed a supplemental in order that the candidates may be hindered as little as possible in proceeding to practice.

MONTREAL.

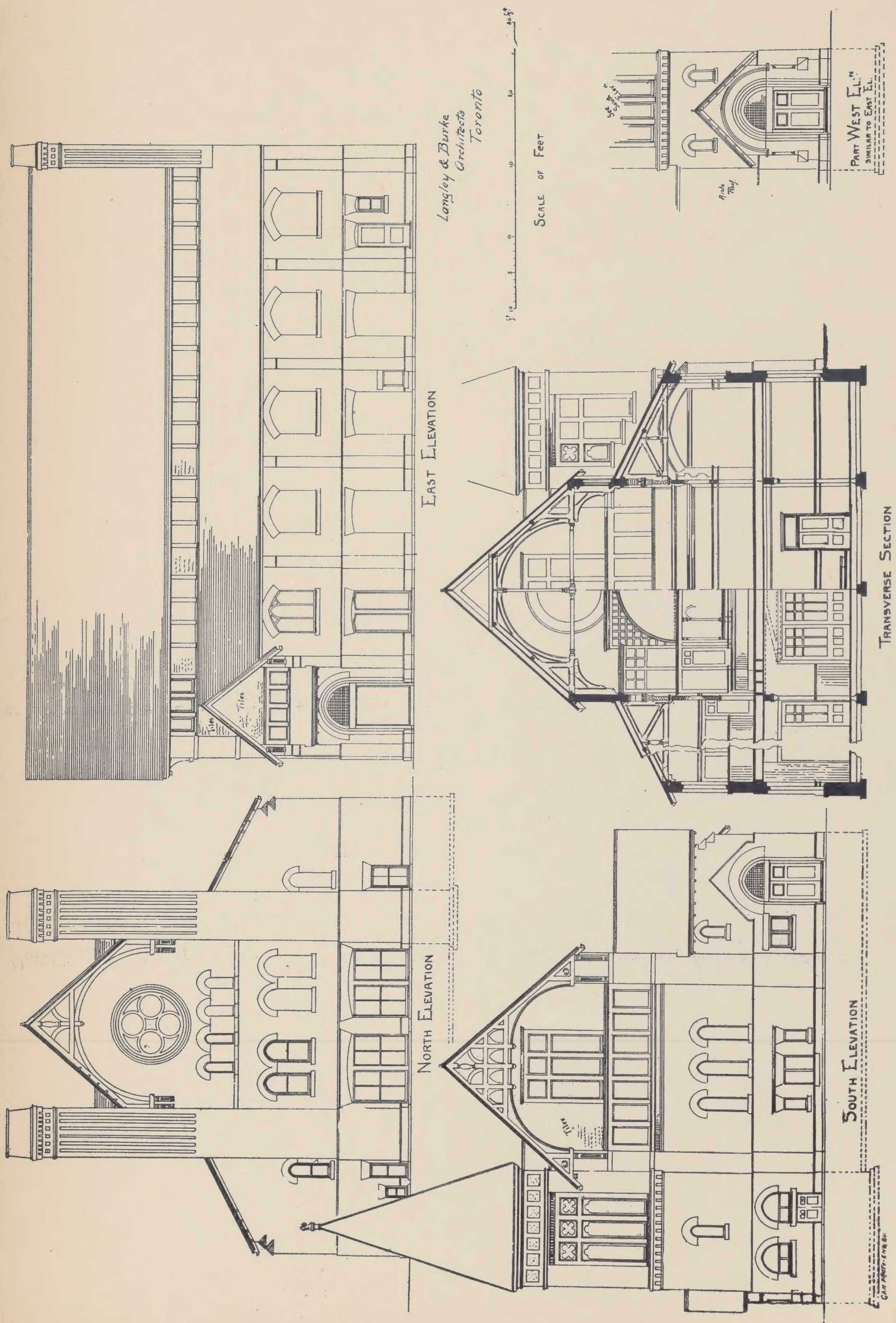
(Correspondence of the CANADIAN ARCHITECT AND BUILDER.)

Mr. J. A. Chausse, architect, is removing his office to No. 153 Shaw street.

Mr. A. Dubrueil, architect, has removed from No. 1639 Notre Dame street to No. 1608 on the same street.

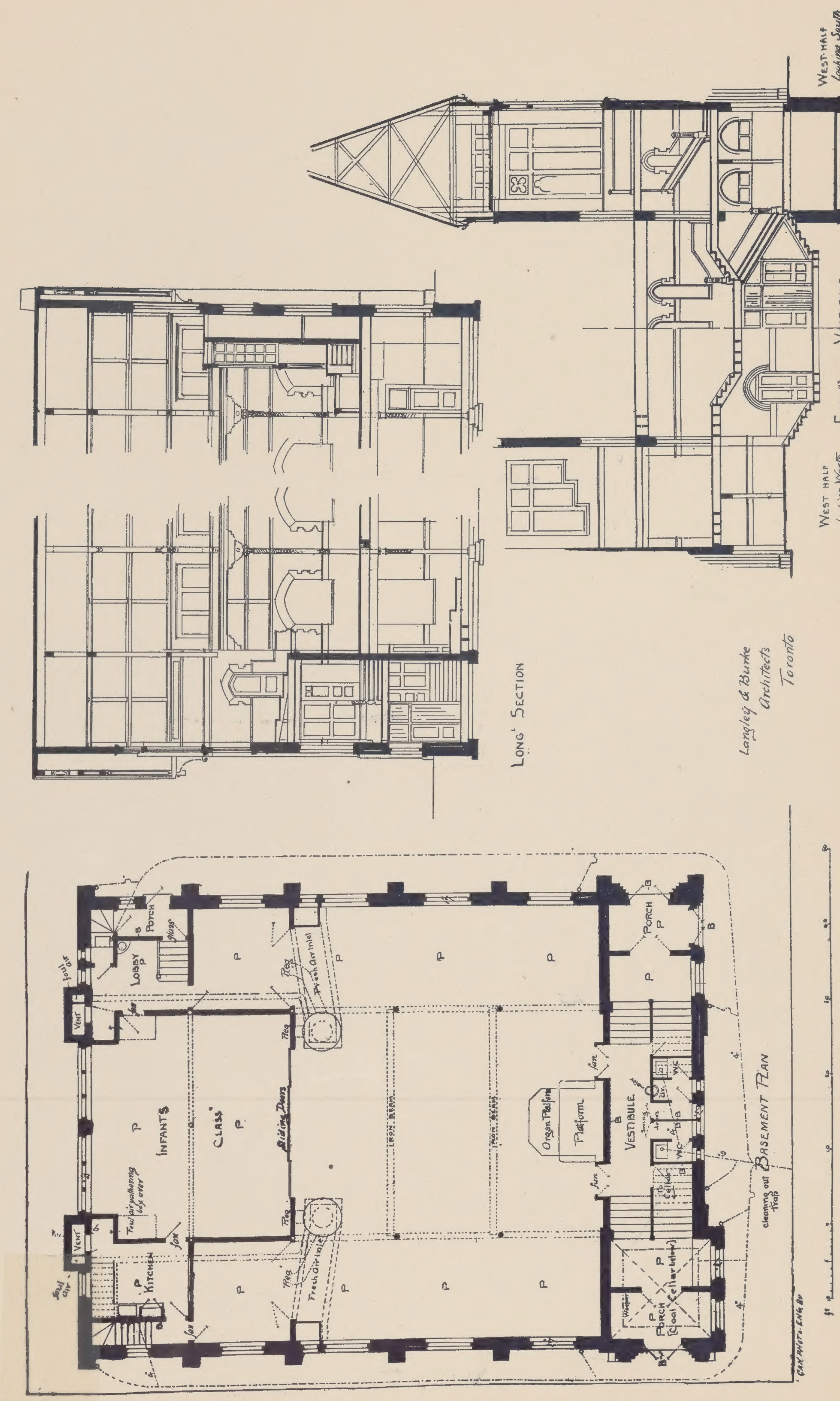
THE Province of Quebec Association of Architects in a communication to the City Clerk, urges the importance of the office of sanitary inspector, and the consequent necessity for caution in the selection of a competent person to fill the position.

"L'Association de Secours des Ouvriers,' is applying for letters of incorporation, with the object of assisting workmen or workwomen who through misfortune are unable to provide for their own maintenance. Applicants for such assistance must furnish if required a certificate of good behavior. The capital stock of the Association is to be $12,000. A number of prominent Montreal contractors are interested in the movement.



BAPTIST CHAPEL, WALMER RD., TORONTO—LANGLEY & BURKE, ARCHITECTS.
(Illustrative of Article on "How to Estimate," in this Number.)

BAPTIST CHAPEL WALMER R^D TORONTO



HOUSE FOR E.A. WILLS, ESQ. TORONTO,

J. FRANCIS BROWN, ARCHITECT, BOARD OF TRADE BUILDING.

FRONT

Sketch for a Church—Submitted by J. Francis Brown, Toronto.

Sketch for a House—Submitted by W. Munro, Toronto.

O. A. A. EXAMINATION IN DESIGN.

HOW TO ESTIMATE.

By W. H. Hodson.

Below are printed specification and bill of quantities for excavator, mason and bricklayer, accompanying working drawings of Baptist Church, Walmer road, Toronto, appearing in this number.

EXCAVATOR, MASON AND BRICKLAYER.

Erect the necessary hoarding in accordance with city by-laws. All vegetable mould to be put to one side for top dressing. Excavate the ground as required for the basement, footings of walls, piers and buttresses, and for drains. Excavation to be 9 in. clear of walls to permit of pointing and inspection. Fill in and ram to walls after inspection ; level to grade shown. Any soil not required for levelling to be removed from premises. Execute drainage as shown with approved salt glazed vitrified pipe of Scotch or American manufacture, jointed in Portland cement and laid to proper fall with all necessary bends, traps, junctions, etc., complete. Put McGuire's cleaning out trap with connection for cleaning carried to within one foot of surface of cellar. Lay weeping drains, as shown, in boiler pit connected with main drain behind proper glazed pipe trap. Connect drain with sewer in street, paying all fees. Footings of walls to be of large flat stones not less than 6 in. in thickness and 4 in. on each side wider than the work above, and to extend to at least half the width of wall above. The footings of large piers carrying main columns to be in two courses of stone of approved quality, 8 in. thick and not more than two stones to each course. Footings of main chimneys to be similar, with not more than three stones to each course. The footings of tower to be similar. The bottom stones to be in length the full width of footing (5 ft.) and not less than 3 ft. wide, the next course to be similar, 4′ 2″ long, and the next 3′ 4″ long. All to be of even thickness, flat on bed and set on a one inch bed of one-third Portland cement mortar. All the footings of main walls and piers to be set in mortar of similar description. The stone walls above finished ground line on north and rear elevations and corridor to be finished with a narrow course of brown Credit Valley stone neatly pointed with brown mortar. The walls on east and west elevations and part of north, as shown, up to level of ground floor window sills, to be faced with the best Credit Valley brown stone in courses of varying heights, and well bonded into wall behind with at least one bond stone to each superficial yard of walling. Stones to be boldly rock faced with narrow margin drift at angles and laid up in dark brown mortar (Cabot's or Pecora) with deeply sunk joint. The walls above coursed work (on tower, east and north elevations) as tinted brown, to be of brown Credit Valley stone in random ashlar work of most approved description, well bonded into brick backing and laid up in similar mortar with similar joint as above. No stone to be more than 9″ in height and a preponderance of long thin stone to be used. The reveals and weatherings to be neatly chiseled, and angles to be finished with narrow margin drift. The walls above the stone work to be carried up in good brick work, composed of the best hard burned bricks laid in the best prepared mortar, well flushed up. The outside to be faced with best machine moulded dark red bricks of even color, laid English bond in dark brown mortar, similar to that for stone work, having a deeply sunk joint. The inside of porch and vestible at rear to be faced with similar bricks of lighter color in the dado, quoins, etc., and with picked white bricks in the walls, all laid American bond and to harmonize with work in present school building. The red bricks of the interior to be laid up in mortar colored with Cabot's red mortar stain, and the white bricks with mortar colored with Cabot's yellow mortar stain, all finished with a neat bead tool joint. The internal window sills to be finished with a course of plinth bricks. The capping of dado to be a plinth brick reversed. The walls of porch and vestibule to be hollow and two half bricks thick. Outer face to be well parged. Tie the half brick walls with stout hoop iron every fifth course and about one foot apart ; iron to be bent —U— thus and dipped in tar. The outer 9″ walls of dressing rooms and vestry to be built English bond. The walls of church to be also built with a 2″ cavity tied with hoop iron as before mentioned, the inside face of outer wall to be carefully parged. The inside walls of auditorium, front vestibule, north stairway and tower (two stories) to be faced with No. 1 pressed bricks in the very best and most workmanlike manner, laid up in English bond with a narrow joint in putty mortar to harmonize in color with the bricks. The dado, the moulded bricks in jambs and arches of the west end and the belts and friezes at east end to be executed with pale brown bricks equal to sample in the architect's office, the walls above dado to be faced with bricks of a yellowish buff tone equal to sample shown. The capping of dado, the angles, jambs, sills, arch bricks and labels as shown to be executed with moulded bricks of approved design ; supply moulded bosses, returns or stops where required. State reduction if all pressed brick work inside (except fireplaces) be omitted and walls (of hollow and similar thickness) left rough for plastering. The jambs, arches and labels of the three entrances in east elevation, windows adjoining and three windows above to be executed with No. 1 pressed and moulded dark brown bricks of approved design laid up in mortar of harmonizing color. The labels over windows in south elevation to be of moulded pressed bricks finishing to moulded stops. There will also be moulded stops to labels of three windows on east elevation. Dentil bricks at eaves of staircase to be moulded and pressed, jambs of staircase windows to be simply rounded.

Brick piers in cellar to be of hardest grey or red bricks, built perfectly solid and having neatly struck joints. The walls of boiler pit to be built with similar bricks in 4″ stone footings, joints to be neatly struck. Carry up flues as shown, properly parge the same, and provide and build in cast iron slides to give access for cleaning smoke flues. Provide and build in 15″ collar in smoke flue with chimney stack. Form fireplaces as shown, those in church to be faced with No. 1 pressed brick of color to harmonize with dado, and having moulded brick courses as shown. Turn arches on wrot. iron camber bars. Form ash dumps properly parged and furnished with cast iron soot doors in cellar. Build brick trimmer arches and level up with concrete to within 1½ of finished floor line. Build vent flues from below ceiling of gallery as shown, two to be carried up in walls of tower into pinnacles, two in south side to be carried into pinnacles of transept, that in north side to be carried into flue in vestry chimney stack, and that at n. e. staircase to be carried up to eave line. The openings in inside to be filled with 12″ x 18″ white enamelled valve registers provided and set by mason.

Arches to windows and doors, &c., to be cut and gauged. Turn proper relieving arches over all openings of at least two rings. Thoroughly clean down all walls (the internal ones with acid), removing all stains or defects, cutting out and replacing any discolored or broken brick, and leaving all perfect on completion. Bed in mortar all wood slips, wood bricks, stone or other work required to be set in the masonry or brickwork. The walls of vestry and dressing rooms will have strips built in for securing battens. Bed in mortar all lintels, plates, etc., and carefully point round all window and door frames. Cut all necessary grooves for flashing, and point up as required. Beam fill on all walls to underside of roof and floor boarding. Build areas of hard bricks in stone footings and pave with brick on flat. Build in carpenters' bolts for copings. Provide good and sufficient scaffolding which is to remain for the use of other trades as required. Take every precaution to prevent walls being discolored from splashings from scaffolding. Form foundation for boiler, say 40x12 ft. with flat stone 4″ thick and on this lay hardest clinker bricks set on edge in sand and well flushed. Lay the boiler pit with similar bricks set in a 4″ bed of sharp sand. The coal and ash pit and space adjoining as tinted grey will be concreted. Excavate to additional depth to allow for boiler. Form foundation with stone chips 6″ deep and on this lay concrete floor 3″ thick formed with coarse gravel, coarse sand and Portland cement in proper proportions and floated to a smooth and even surface. Provide and set on brick piers under the eight main columns squared and dressed approved stone 32″ x 32″ x 12″ thick. The piers carrying six small gallery columns to be coped with approved stone 8″ thick and those carrying beams with stones 4″ thick. All to have dressed beds and to be correctly squared. Provide similar stones 8′ x 12′ x 4″ under beams when resting on walls. Cope walls of ash and boiler pit with approved stone 9 in. x 4 in. thick in long lengths, dressed and carefully set in Portland cement. Cope chimneys with Credit Valley or other approved brown stone 9 in. thick, and in not more than two pieces to each stack, cramped and set in Portland cement. Sills of basement windows to be of Credit Valley stone (brown where exposed). Sills of vestry and dressing room windows may be executed in Berea or brown stone of approved quality, seated, weathered, throated and rock-faced. The heads, strings and sills of all other windows to be executed in the best description of Credit Valley brown stone, free from all flaws and defects, tooled or chiselled as may be directed, weathered, seated and throated. Sills at random work may be rock faced. The steps and landing at main entrances to be of same Beren or equally approved stone, carefully set in long lengths in Portland cement and joints thoroughly flushed. The coping of parapet of front gable to be of approved brown Credit Valley stone in long lengths, set in Portland cement and weathered, tooled and throated as directed. The carving of the four bosses at entrances and the finial on coping is reserved. Prepare for carving as required. The eight corbels, side walls under principals, and the two corbels at the east end carrying foot of principals, the four corbels under iron beams at tower and staircase openings, the four corbels under gallery brackets, the cornice at spring of arches at west end, and the heads of two fireplaces to be of light brown stone of approved description, moulded and rubbed. Sills and exposed stonework to be boarded over immediately upon being set.

BILL OF QUANTITIES.

EXCAVATION AND DRAINAGE.	$	c.
Board fence, etc., as per city by-laws		
1100 cubic yards of excavation, basement walls, piers, buttresses and drains ; includes filling, ramming, levelling, etc., etc.		
101⅔ lineal yards of vitrified pipe drain ; includes bends, traps, junctions, etc.		
13 lineal yards of 4 in. weeping drain, complete		
Provide 9 in. continuation drain from sewer to street line at per lineal yard, complete, paying fees for same		
1 McGuire's cleaning out trap with connections		

Note.—Excavations are measured "cube," that is, length, breadth and depth, thus : 54 ft. 9 in. x 22 ft. 6 in. x 5 ft. 6 in. = equal to 6775 ft. 4 in. divided by 27, the number of feet in a cubic yard, gives 251 cubic yards, less (1 ft. 8 in). Tile drains are measured lineal, that is, running measure, as indicated in above items.

MASONRY AND CUT STONE.	$	c.
157 toise of masonry, complete, including the footing laid in cement		
2080 supl. ft. of coursed Credit Valley brown stone, varying heights pointed in brown mortar, includes margin, draft, etc., chiseled reveals		
20 supl. yards of foundation to boiler. 6 in. stone chips and 3 in. thick concrete, smooth surface		
131 lineal ft. of narrow coursed Credity Valley stone, pointed in brown mortar		
72 lineal ft. of Credit Valley brown stone coping in long lengths set in cement		
50 lineal ft. of Credit Valley brown stone coping, parapet of front gable, long lengths, set in cement		
18 Credit Valley cut stone sills, 6 ft. 6 in., weathered, throated and seated		
7 Credit Valley cut stone sills, 5 ft. 0 in., weathered, throated and seated		
5 Credit Valley cut stone sills, 3 ft. 6 in., weathered, throated and seated		
10 Credit Valley cut stone sills, 2 ft. 6 in., weathered, throated and seated		
7 Credit Valley cut stone sills, 2 ft. 0 in., weathered, throated and seated		
8 column stones, 32 in. x 32 in. x 12 in.		
6 coping stones to gallery columns, 8 in. thick, dressed		
6 coping stones to beams, 4 in. thick, dressed		
8 stones for beam rests, 12 in. x 8 in. x 4 in., dressed		
2 coping stones of Credit Valley to chimneys, in two pieces, set in cement and cramped		
26 light brown stone corbels front of principals, spring of arches, etc., etc.		
4 boss stones (for carving) and finial		
2 Berea stone steps and landing, main entrances, in long lengths set in cement		
4 double footing stones in cement mortar under iron pillars		
Boiler foundation, 480 ft. of flat stone 4 in. thick, covered with hardest clinker brick set on edge ; well flushed		

Note.—Masonry is measured cube and the totals of dimensions added together, divided by 86, the number of cubic feet in a toise. The French measure per toise being 6 ft. x 6 ft. x 2 ft., equivalent to 6 ft. 4½ in. x 6 ft. 4½ in. x 2 ft. 1½ in. English measure, the French foot being ¾ of an inch longer than one foot English. Cut stone facing measured superficial, that is, square, thus : 5 × 5 gives 25 ft.

BRICKWORK.	$	c.
60,000 (A2) best hard burnt brick, with white, red and plinth, to sills, and reverse to dado, a proportion of pressed and pale brown brick equal to sample bricks, etc., smooth jointed		
27,500 machine made bricks, laid in brown mortar, tied with hoop iron at cavity		
6,100 (A1) red and white and pressed brick facing to porch and vestibule		
2,900 hardest grey bricks to piers		
2,300 bricks, moulded for dado capping, angles, jambs, sills, arches, lables, etc., etc.		
1,000 dentil moulded and pressed bricks to stair case window		
170 hardest clinker bricks to boiler pit, on bed of sharp sand		
23 supl. yds. of concrete, to coal and ash pit		
800 hoop iron ties dipped in tar		
50 relieving arches, double rims, throughout building		

	$	c
4 12 in. x 18 in. enameiled valve registers, complete		
2 cast iron slides to smoke flues		
2 15 in. collars to smoke flues		
Arches over two fire places and wrought iron camber bars		
Ash dumps and cast iron soot doors in cellars		
Trimmer arches and concrete to within 1½ in. from floor		
Vent flues from gallery ceiling, two to be carried up into wall of tower and one in vestry; chimney stack up to eave line		
Cleaning down walls, removing stains and defects, bedding timbers, building in strips for battens, pointing to windows and door frames, grooving for flashing, beam filling, bolts for coping, etc., etc., complete		
Scaffolding as required and remaining for other trades		
Deduction if A 1 and 2 is not carried out		
A 1 deduction, pressed brick ommitted and instead left rough for plasterer		
A 2 deduction, pressed brick omitted and instead left rough for plasterer		

NOTE.—Brickwork is measured cube and in Montreal the number of bricks given in estimating is 20 bricks to the cube foot, and is ascertained thus:

```
6 bricks long say  4′ 0″
9   "    high  "   2′ 0″
                   ------
54                 8′ 0″ = divisor.
 3 brick thick

8 | 162 | 20 to the foot.
     16
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The openings are measured and deducted from the solid work. Concrete when not deep is measured by the superficial yard, thus: 3 ft. x 3 ft. gives one yard. Concrete in heavy work is measured cube, 3 ft. x 3 ft. x 3 ft., or 27 ft. to the cubic yard. Arches, etc., are given in numbers and other items noted as above.

(To be Continued.)

SANITATION·HEAT·LIGHT

VENTILATION.*

SOME extracts from various reports of scientific men on the subject of the ventilation of Halls of Assembly which from many years of study I believe to be the best solution of a very difficult problem:

Two systems of ventilation so far appear to have been adopted, viz., the upward or the downward exhaust.

The fundamental principles of ventilation are:

1st. Heated air is relatively lighter than colder air, and will continue to ascend and the cold air to descend so long as they are free to move.

2nd. More or less than a given quantity of air practically considered cannot occupy an apartment and cannot be introduced unless an equal quantity be withdrawn, or withdrawn unless an equal quantity be introduced.

These two simple and self-evident propositions will explain nearly all the phenomena observable in ventilation. The first method adopted by engineers and architects to give movement to air for the ventilation of mines and buildings was to heat an upflowing column, thus lessening its specific gravity and causing it to rise with corresponding force. That system was employed in the British Houses of Parliament, where in many of its towers a charcoal fire was kept burning and thus a force obtained to propel the air through the building. It has been practically demonstrated, however, that one pound of coal burned in the furnace of a steam boiler to drive a fan blower will generate as much force and consequently is capable of producing as strong a current of air as 38 pounds expended in heating a column of air to act by its diminished gravity. If heated air is introduced into an apartment containing air at a lower temperature through registers at the floor, it rises rapidly to the ceiling, and if there are openings at the ceiling it escapes without (except in a very slight degree) mixing with the air in the apartment. The air that passes off in this manner is absolutely lost and the heat imparted to it wasted. It does not remove the vitiated air contained in the lower part of the apartment, it does not form with it a homogeneous mixture and does not communicate to it more than a small portion of its heat.

But if, instead of escape openings at the ceiling they are placed at the floor, the phenomena observed will be widely different. The heated air will as before rise to the ceiling, but instead of escaping, will press the colder air downward to the exit ducts and fill the apartment with pure warm air; the air vitiated by breathing will at once sink below the level of the mouth and in a few seconds will be carried off, no accumulation of foul air being possible.

Various opinions are given as to the amount of fresh air necessary to render the products of transpiration and respiration innocuous. These estimates made by distinguished observers vary from 2 to 50 cubic feet per minute. These estimates and are generally based upon the hypothesis that the fresh air introduced into an apartment mixes uniformly and homogeneously with the vitiated air and dilutes it to an extent to render it innocuous; but if instead of mixing with the air of the apartment, the warm pure air should rise to the ceiling and escape, all conclusions based on the hypothesis of homogeneous mixture would be fallacious. If the air that has once been respired could be immediately removed without being the second time taken into the lungs, it is obvious that so far as respiration is concerned no more need be introduced into an apartment than can be breathed; this amount is easily calculated.

At a temperature of from 65° to 70° Fahrenheit the following average results are given by Dr. Wetherill for the respiration of an adult: Number of respirations per minute, 20; cubic inches of air inhaled at each respiration, 20; cubic inches per minute, 400. The carbonic acid exhaled is stated to be 15 cubic inches per minute, and the surrounding air vitiated is 2½ cubic feet per minute. Four hundred cubic inches is less than one fourth of a cubic foot and this is all that can be taken into the lungs per minute.

The House of Representatives at Washington is provided with 60 cubic feet per man per minute, and yet the vitiated air is not removed. The quantity of air introduced is twenty times as great as the quantity that could be vitiated by respiration provided there was a homogeneous mixture. The facts which are daily observed prove that such a homogeneous mixture does not exist under the present system. If nineteen-twentieths of the heated air which enters the apartment escapes without being utilized, it follows that nearly all the fuel consumed in heating it has been wasted.

In the process of respiration 15 cubic inches of carbonic acid per man per minute are ejected from the lungs. This gas in course of time would diffuse itself throughout the apartment, but it is well known that its density is so great that it can be poured from one vessel into another, or if poured into an inclined trough it will flow downwards, extinguishing successively a row of lights.

The specific gravity of this gas is 1.52 or 52 per cent. heavier than air. Its tendency would therefore be when exhaled to sink below the level of the mouth and occupy the lower portions of an apartment near the floor, but it has been supposed that the elevated temperature at which it is projected from the lungs causes this gas to rise and escape at the roof; the fallacy of such an opinion can, however, be readily proved. Even if the temperature at which carbonic acid escapes from the lungs should be so elevated as to render it momentarily lighter than the surrounding air, it would soon part with the excess of heat and then seek the level due to its superior density—but in fact under the condition of things which actually exists there is only 20° difference in temperature between the air when first expelled from the lungs and that of the apartment. As air increases in volume 1-460 of its bulk for each degree of Fahrenheit, the effect of increasing the temperature 20° would be to reduce the specific gravity less than ten per cent., and the carbonic acid upon leaving the lungs would still be 40 per cent. heavier than the air of the apartment. It would seem impossible for this dense gas to rise to the ceiling and escape at that level without a violation of the laws of pneumatics, unless by powerful mechanical means.

Dr. Wetherill reports that each flame of gas consumes as much oxygen and gives out as much carbonic acid as five human beings.

General Morin reported that a ventilation of 14½ cubic feet per man per minute *principally downward* left no perceptible odor in a lecture room, while the upward ventilation of the Halls of Congress with 60 cubic feet per minute, is notoriously defective.

As regards the direction the products of respiration take after leaving the body, the evidence in support of the tendency to rise is from a report from the Smithsonian Institution; its author seems to have smoked a pipe at the Institute and the smoke ascended—but the objection to this experiment is that tobacco smoke is not one of the ordinary products of respiration. The experiment does not prove that the gray smoke which was seen to rise was carbonic acid. The experimenter does not state in what direction were the ventilating currents in the apartment or how produced, and there was nothing in the experiment to prove that with a gentle downward ventilation the smoke would not have moved downward instead of upward—in fact it proved nothing at all in reference to the direction of the products of respiration.

Lewis L. Leeds quite agrees with General Herman Haupt in conclusions both as to theory and the necessity for putting in practise a system of exhaust for ventilation from the floors of the house, and says very extensive practise and close observation for many years past have fully convinced him that the human breath, which is the great source of contamination tends first towards the floor in a still room of 70°, and that there is a probability in a closely occupied room that there will be quite an excess in the accumulation there. This applies to rooms warmed exclusively by heated air. The contrary opinion—that is the assumption that the breath and the impurities exhaled from the body rise to the ceiling and accumulate there—was advocated strongly in the ventilation of the English House of Parliament, and it is reported that some two or three millions of dollars were spent in endeavoring to heat and ventilate that building comfortably, and as the proceedings in regard thereto were spread over the world to an extent probably one hundred times greater than any previous publication or action in regard to ventilation of any public building, that theory of ventilation became strongly impressed upon the public mind as being the correct one. I consider that idea erroneous, hence all theories of ventilation based upon it are consequently wrong. In the majority of our rooms the heated air entering (which, of course,

*Paper by Thos. Fuller, Chief Architect, Dominion Board of Works, read by Mr. Billings at the Second Annual Convention of the Ontario Association of Architects.

must assume to be pure air) does not enter warmer than the contained air one half of the time and probably not more than one quarter of the time. Mr. Leeds goes on to advocate an open fire and further states—"I believe it would be at all times and under all circumstances very desirable to have a large amount of the air drawn from the floor as nearly as possible under or near each member's seat, and also from under the seats of all the benches in the galleries, but to know how or when and how much to draw from the ceiling would be a much more difficult question to decide. That there should be such openings we know from everyday experience, the necessity for opening doors or lowering external windows to relieve the upper part of a room when it gets too warm. The openings at or near the ceilings require to be closed or opened according to the varying conditions of the room. Heat applied within any building causes movements of the air with more or less force according to the difference of temperature of the external and internal atmosphere. The external wind is a source of considerable power. It is important in the application of power, either to make it conform to and cooperate with the natural forces and merely assist their action, or otherwise make it of sufficient power to entirely overcome all these natural forces—if much care is not exercised in the adjustment of these forces one just counterbalances the other and stagnation is the result. Scientific and medical authorities generally concur in the opinion that in-door air after heating should contain nearly the same proportion of moisture as the average of out-door air of the same temperature, but when air is brought in from out of doors at a temperature of zero and raised by heaters to 68°, it would require the addition of 4.343 grains of water per cubic foot of air to bring it up to the required degree of moisture. For the proper moistening then of fresh, warmed air introduced at the rate of 20 cubic feet a minute for each one of three hundred persons two hours, the air taken at zero and at an average degree of moisture, no less than fifty-nine gallons of water would be required to be added. Exactly how much vapor or what per cent. of moisture is the most healthy has not yet been determined. From much observation we have taken 65 per cent. of saturation as the amount most likely to prove healthy—the mean relative humidity of the air at Philadelphia for the year 1863 was 57.2, and the mean average for twelve years, 68.5.

Dr. Wetherill in his report on ventilation of the Capitol at Washington says: "Hood, ("Warming and Ventilation,") estimates the air required for ventilation by the amount needed to take up the moisture from the skin and lungs. The air required for respiration (*i. e.* oxidation) is very much less than that needed to hold in solution the vapor of the skin and lungs, which evolve 12 grains of water per minute.

If the temperature of a room be at 60° with a dew point of 45°, a cubic foot of air will absorb 2¼ grains of vapor, or, in other words, the perspiration from the body will saturate 5¼ cubic feet of air per minute. If, however, we take the dew point lower, say not to exceed 20° or 24°, then 3¼ cubic feet of air per minute will be required to carry off the insensible perspiration, while, for the pulmonary supply one-fourth of a cubic foot will be needed, making a total of 4 cubic feet. In summer, as the dew point is higher, more air will be needed, viz., 5 cubic feet per minute for summer ventilation. In a foot note to the above it is stated that Seguin gives the exhalation of water from the lungs, 7 grains, from the skin, 11 grains, total grains, 18 per minute. If the dew point is maintained uniformly at 52° the following is the calculation of quantity exact for this case: A cubic foot of air at a temperature of 65° with the dew point at 52° will absorb 2½ grains of vapor, and if we take the mean of the two authorities above cited regarding the quantity exhaled by each person, we will have 15 grains per minute, and to absorb this under the above conditions will require 6 cubic feet of air. Add to this the one-fourth cubic foot required for breathing, and we have 6¼ cubic feet as the total amount vitiated per minute. The surface of an average man is about 18 square feet. If, therefore, we imagine such a man walking in the pure open air at the rate of two miles an hour on a perfectly calm day the air will be flowing past him at the rate of 176 feet per minute, and as he is one foot deep from front to back, the average thickness of the envelope of vitiated air which surrounds him may be found as follows:

Let A = The quantity of vitiated air per minute in cubic feet .. 6¼
B = The surface of the person in square feet 18
C = The extent of the person in direction of the current of air in feet 1
D = The velocity of the current in feet per minute 176
x = Thickness of envelope in inches

Then
$$\frac{12\ A\ C.}{B\ D} = x$$
and x = 0.018 or 1/55 of an inch.

In supplying air for the upward ventilation of a hall containing an assemblage of people, however, it is absolutely essential that the direction of the current should be vertical, otherwise that which has been vitiated by one person would be given to another to breathe and perspire into. If we now assume a man standing upright of the average height of 5′ 6″, and the velocity of the current at 5 feet per minute, we will have for the value of the terms in above formula: A = 6¼; B = 18; C = 5⅔ D = 5; whereupon x = 4.16 inches.

If this envelope of 4″ thickness be drawn upward, it is clear that the nose and mouth will be always supplied entirely with vitiated air, no matter how pure it may be one foot away, while if it is drawn downward those organs will always be supplied with perfectly pure air. This consideration alone is quite sufficient to determine in favor of downward direction; there are, however, some other advantages in the downward over the upward direction. The temperature of the human body varies 2° either way from 98°, a sudden variation of 5° or 6° being said to be fatal. If, therefore, the air is supplied at a temperature of 65°, it will be 32° cooler than the body. With a downward current the head will be in this cool air while the feet will be inclosed in an atmosphere nearly if not quite as warm as the blood within them, and to "keep the head cool and the feet warm" is one of the fundamental rules of hygiene as well as of comfort.

A current of air coming up through the floor will always bring along with it the fine dust which the greatest care cannot prevent accumulating there to an extent which renders it unpleasantly sensible in all assemblages supplied with an upward ventilation. With the downward ventilation it is only necessary that the dust shall be thoroughly removed from the inflowing air at the mouth of the inlet duct to maintain the hall perfectly free from dust.

Again, with upward ventilation the entire hall is filled with vitiated air, the vitiation having taken place near the point of admission, while with the downward ventilation the ventilation takes place near the point of exit and the whole upper part is full of pure air. In a hall say, 36 feet from floor to ceiling, and the fresh air is admitted through apertures well distributed in the ceiling—it has thirty feet to move before it comes in contact with the heads of persons on the floor. During this movement all eddying currents induced by the increased velocity with which it is necessary that it shall pass through the apertures have become quiet, and the whole mass descends with an uniformity impossible to obtain in the vicinity of persons ventilated with upward ventilation, and one of the most important considerations to be kept in view in ventilating an apartment is to avoid perceptible draughts. Mr. Goldsworthy Gurney, in his examination before a Committee of House of Lords, said: "We have found the down current always more agreeable; the up current is sometimes used, but it is not so pleasing and not so effectual."

One objection used against the downward system is that it is against nature to force air downward. Although this opinion is entertained by an extremely large number of otherwise well-informed persons, every engineer of ordinary attainments knows perfectly well that it is as easy to force air in one direction as another. Another objection is, that as air is additionally warmed at the same time it is vitiated, that which is vitiated and warmed has a tendency to rise whatever may be the direction of the general mass surrounding it. This is true, but this tendency is so feeble that its opposition to a current of 5 feet per minute would not be perceptible. It has been shown that with a vertical current of 5 feet per minute the mean thickness of the envelope of vitiated air surrounding a man of the average size when standing is 4″, this more than two hundred times as thick as when he is walking at the rate of 2 miles an hour in a perfect calm. As, however, the air has to be brought from such a direction that mouth and nose are always supplied with air of absolute purity, to insure the control of its direction by mechanical means, a current of 5 feet per minute has been assumed for the minimum velocity to be given.

When the weather is fine, or in other words, when the outer air from which the supply is derived is in the desired condition as regard temperature and moisture, and no expenditure is required upon its conditions, then a maximum amount may be given, the minimum being employed when its condition as regards temperature and moisture has to be changed to the greatest extent. The only limit to the amount of air it will be advantageous to supply is that fixed by the rule that the currents past the person must not be sufficiently rapid to become sensible.

Some persons are sensible to currents of much less velocity than required to render others conscious of them. Most people can feel a current having a velocity of 150 feet per minute, very few can perceive one of 90 feet per minute. To be quite sure that no one, however delicate, should be conscious of being in a current, the maximum current would be safe at 50 feet per minute. But 10 feet per minute will give a bountiful fresh ventilation. The average thickness of the vitiated envelope will then be two inches, or one hundred times thicker than when walking out doors in a calm. With downward ventilation, however, the nostrils are in pure air equally as when walking, the vitiated air enveloping the lower part of the person only, leaving him unconscious of its presence.

Even when the weather is good and the temperature of the air delightful and the wind blowing with the most desirable force, an open window in the side of a great hall filled with an assemblage of people would furnish air to those furthest from the window filled with emanations of all the persons it has passed on its way.

That the air as vitiated has a tendency to rise has been a favorite theory among scientific men. Mr. Gurnev was one of the first to stoutly deny the fact in his testimony before Committees of Parliament; he asserted that the downward propulsion which the breath received by the position and direction of the nostrils did not cease so far as the impurities with which it is laden are concerned, till it deposited them on the ground, also that on a frosty day the vapor from a person's mouth may be seen to describe a parabolic curve to the ground. But any one may see

the vapor of the breath driven from the nostrils taking at first a downward course; a breath of a fair strength, with the thermometer near freezing point, may be seen by its condensed vapor driven downward and slightly outward for a foot or more.

In this observation, a wind wheel (in air of 26° Fahrenheit), moved rapidly near the body, and steadily at a distance of six inches in front and also at two feet above the head. Notwithstanding this upward current, the breath was strongly marked by condensed moisture fourteen inches below the nostrils, and, would doubtless have been seen further down but for the dissipation of the moisture.

In a room with the air at 65° the same wind wheel was in motion close to the vital parts of the body, but stopped entirely at two or three inches distance from the body or above the head—this was anticipated, because the force that carries the wheel is the rising of the air in consequence of its greater heat and lightness than that of the surrounding air, and is proportioned to the difference of temperature. In order to determine the amount of heat operating to cause the air to rise, a thermometer was placed within the clothing near the vital parts of the body, where it was found to stand at 82°, while the person remained in air at 65°. On going into air at 20° with additional clothing, the thermometer stood at 76°. The air around the body in a warm room, therefore, would rise with a force not far from 17°, while in the outer air at 20° it would rise with a force not far from 56°. Probably the air would rise with a velocity somewhat less than these figures, but relatively they are nearly correct. A more sensitive instrument would have been affected at a greater distance, but the same wheel showed a distinct downward motion of the breath 15 inches below the nostrils in opposition to all the rising tendency by reason of the warmth of the breath and air about the body, and this motion would have been shown at a greater distance by a more sensitive wheel.

Let us now suppose, to be well within bounds, the breath to be moved 12 inches below the face, the downward motion having ceased, the upward motion should then begin, which is to carry the breath up out of the way. This old breath has about one second in which to rise from rest or reverse motion, more than 12″ in order to be out of the way of the next inhalation. The difference of temperature necessary to give this movement of 12 inches in the first second, if the breath rises by heat alone, will surprise anyone not familiar with such calculations, it is not less than 180°, that is to say, the breath in order to start from rest and rise 12″ in one second through air at 65°, would have to be at a temperature of 245°.

The absurdity to which this calculation and experiment reduce the idea that our breath is carried away from the face by its upward tendency from heat, is increased by the observations which every one may make, that a thermometer at 65° cannot be raised more than one degree by breathing upon it at 9″ distance, and that at 10″ no effect can be perceived. Under the most favorable circumstances all causes combined are not sufficient to carry the expired breath up out of the way before another inhalation, as may be seen on a frosty day, and it is evident that the air contaminated by the body, if carried upward must be inhaled.

We will consider the circumstances of a large hall of assembly and show the operation of the two systems. Suppose a floor well packed with people at the bottom of a cubical or hemispherical hall: suppose them to have entered at once, the hall being previously filled with pure air; directly the lower stratum of air in which is the audience, becomes contaminated by their exhalations and emanations. Now the problem is to get that stratum of air out of the hall before any of it can come into use again, and to replace it with fresh air of the right temperature.

It is obvious that it cannot be taken out sideways, because then many would have to breathe over again the breath of others—it can be taken only either up or down. If taken up, the fresh air that is to supply its place must enter at the floor from which the foul air rises, for no air will leave the spot till other air is ready to fill its place. In order to lift the whole of the foul air bodily from the floor, it is necessary that the whole floor should be open for the admission of fresh air. Wherever there is a piece of solid floor through which the air cannot pass, there will be a dead space of foul air above it which will not rise with the rest, but will remain to be gradually mixed with the fresh air entering around it. If the dead space is considerable, the whole amount of air required must enter in the limited space of the openings, and the velocity must be proportionately increased. According as the space is reduced and the velocity increased, the air entering has a force that carries it up beyond the place where it is to be used, and mixes it with the foul air passing off, a part of which mixture will return in counter currents and gradually replace the air in dead spaces.

Dr. Reid, of the House of Commons, England, the most scientific and experienced, perhaps, of the advocates of the upward system, seeing this necessity for introducing the fresh air through the whole extent of the floor, had the entire floor made of perforated iron. This was afterwards covered with hair-cloth carpeting, and through nearly its whole extent the fresh air was admitted. The result was, that on account of the rising of dust by the entering air, and still more on account of the uncomfortable draughts brought up against the members' legs, nine-tenths of the floor was covered with sheet lead under the carpet. When the entrance for fresh air was thus limited complaints became so loud both of strong currents and of foulness of air, that the whole matter of ventilation was turned over to Mr. Goldsworthy Gurney, who undertook it on the opposite system of introducing fresh air above and taking out the foul air at the floor.

It is very important in the warming and ventilating that the pure air to be supplied should be of the same degree of temperature and the same amount of moisture as that of an open space in a pleasant time in summer.

With respect to the actual degree of ventilation necessary for health there is great difference of opinion. The following volumes of air in cubic feet per person and minute have been assigned by different experimenters: Dr. Arnot, 2 to 3; Tredgold, 4; Mr. Toynbee, 10; Dr. Bell, 10 to 25; Peclet, according to circumstances, 10 to 20; Peclet, at least 5; Roscoe, (insufficient in Barracks), 10; Roscoe requires at least 20; Dr. Reid, minimum, 10; Dr. Reid requires according to circumstances, 20 to 60; Vierordt, 2½; Hood, ("Warming and Ventilating") estimates the air required for ventilation by the amount needed to take up the moisture from the skin and lungs. The air required for respiration (*i. e.* oxidation) is very much less than that needed to hold in solution the vapor of the skin and lungs which evolve 12 grains of water per minute. If the temperature of the room be at 60° with a dew point at 45°, a cubic foot of air will absorb 2¼ grains of vapor, or in other words, the perspiration from the body will saturate 5¼ cubic feet of air per minute. If, however, we take the dew point down say not to exceed 20° to 24°, then 3¼ cubic feet of air per minute will be required to carry off the insensible perspiration, while for pulmonary supplies ¼ cubic foot will be needed, making a total of 4 cubic feet. In summer the dew point is higher, more air will be required, viz., 5 cubic feet per minute for summer ventilation.

Professor Miles in his report on ventilation of houses and schools assumes that if the temperature of the air ranges from 65° to 70 degrees Fahrenheit, we have the following average results from the respiration of an adult: number of respirations per minute 20; cubic inches of air inhaled and respired 20; cubic inches of air inhaled per minute 400; cubic inches of oxygen each respiration 4; cubic inches oxygen each minute 80; products respired: 1. damaged atmosphere with nitrogen in excess; 2. fifteen cubic inches of carbonic acid gas; 3. three grains of vapor of water.

The surrounding air is vitiated by the mixture of the products of respiration with it at the rate of 2½ cubic feet per minute. The total average loss by the lungs and skin in twenty-four hours is almost 3½ pounds of water, of which somewhat more, ⅔ say 2½, are furnished by the skin, of these 2½ pounds (only 1/6) is furnished by the vital process of secretion by the sweat glands, for the greater part of the moisture transudes through the skin by simple evaporation. For health the body must evaporate a quantity of water within certain limits; the amount evaporated is influenced by the hygrometric condition of the air and by the state of the body itself. The evaporation is increased by muscular action and by a dry atmosphere, it is diminished by repose and by a moist air.

EXTRACT FROM THE REPORT OF A SELECT COMMITTEE ON THE VENTILATION OF THE HOUSE OF COMMONS, LONDON, PRINTED MAY 31ST, 1886.

"The plan adopted and worked for many years under the superintendence of Dr. Percy consisted in drawing the fresh air into the House and the vitiated air from the House by means of heated shafts in the clock tower and in Victoria tower. By this exhaust process the air in the House was placed under a somewhat lower pressure than the air outside, and a pull thus created which caused the entry of foul air from any accidental source of impurity within reach of this pull, as from closets, etc. Since this plan was established many years ago much progress has been made in the art and science of ventilation, especially in mechanical appliances for the purpose, and by means of these, greater efficiency and certainty, as well as increased economy in working was attained than was possible under the older system.

The great advantage of mechanical ventilation is that as the air is pumped in, a slight excess of pressure exists in the ventilated spaces over that in the outside, and therefore any section of air from impure sources, such as imperfect soil pipes, closets, etc., is avoided. The Committee, for the above reasons, are of opinion it is advisable to cut off the exhaust so that the air pressure may be above rather than below that of the external atmosphere." But it appears by evidence given before the Select Committee of the House of Commons on ventilation, June 1891, that the recommendation in the previous reports had only been carried out to a limited extent, and that the system of extracting the vitiated air at the ceiling is still in operation—the witness stated that air drawn from the Court Yard passes by steam batteries by which it is warmed—it then passes down the floor of the house which is perforated all down the centre and in various other parts, there it ascends through the ceiling and passes down four shafts about 700 feet in length to the basement and then horizontally through the basement for a considerable distance and discharges into the Clock Tower where there is a very powerful up cast, which must require a very much larger consumption of fuel than would be necessary if the exhaust were from the floor of the House by mechanical means.

POSITION OF HALLS.

Some adverse criticisms having been made with respect to the House of Representatives at Washington being surrounded by

rooms, and not having any contact at the sides with the external air. In a report to Congress the objection is thus met, "It is supposed by many that the inclosure of one building within another, the inner one being the hall, is a serious defect in the construction with a view to equable temperature and a healthy ventilation; on the contrary, it is a great advantage. If the hall approached the exterior wall it would be subject not only to all the internal changes of temperature and elements disturbing the ventilation, but also to all those of the external atmosphere and the weather. Almost every one of the disturbing elements that have been named would be greatly aggravated if the hall approached the exterior. External influences like those of noises, winds, and storms would make themselves felt disagreeably which are now altogether excluded. There is no doubt that the more perfect the ventilation is the more perfect the acoustic properties of the hall will be. A pure atmosphere being favorable to the speaker's health and strength, will give him greater power of voice and endurance, thus indirectly improving the hearing by strengthening the source of sound, and also enabling the hearer to give his attention for a longer period.

In compiling the foregoing remarks, the various reports to Congress by A. C. Stimers, Naval Engineer, General Haupt, L. W. Leeds, Capt. Meigs, E. Clark and others, have been freely quoted, also reports of Select Committee on Ventilation of the House of Commons, London.

After many years of study and experience I am strongly of opinion that the most efficient system of ventilation for halls for the assemblage of large numbers of people is by the introduction of fresh, pure air heated by passing over steam or hot water pipes in chambers and driven and exhausted by the most approved appliances, introducing the pure fresh air at the ceiling and exhausting at the floor, which may be termed the downwards draught and plenum system.

SANITARY PLUMBING.*

By Cesare J. Marani, Grad. S.P.S.

(*Continued from April Number.*)

That in so far as it lies within our power, the waste pipe system be freed from any tendency to retain decomposing matter, giving off gaseous products known to be detrimental to health, or these very gases when generated elsewhere.

From the mechanical side I should say, have the work done by a thoroughly reliable and competent workman, one who knows and realizes the importance of honest workmanship in connecting pipes, in ventilating traps, etc. To place the work in the hands of an admittedly good man, a thorough mechanic in himself, but one who always employs undermen to do his "jobs," and then to rest at ease with the false idea that your share of the work has been performed, and that the workmanship will turn out as desired, reminds me of the story of that simple-minded housewife, who, after placing her marketing of game and fowl on the table of her cottage, and then firmly securing the windows as against the ingress of eagles and other birds of prey, went off leaving the cottage door wide open. During her absence, the fable goes on to say, bears, and other beasts, entered and carried the marketing away.

It is the duty of the architect to determine whether the men actually doing the work are competent or not; and further, he should insist that the work be done by competent men, and competent men only, otherwise all kinds of defects will crawl into the system and prove beyond detection when the work is finished.

Recesses due to badly constructed joints, beads, and strings of solder, or the ends of gaskets in the pipe, all tend to retain filth. Bad connections between vent pipes and traps, destroy the efficiency of the latter. Unnecessary traps, or want of sufficient grade, are again, blunders for which the architect or designer of the plumbing system is alone to blame.

The sizes of the soil pipe and waste branches have also an important bearing on this point. For unless they are so proportioned as to be self-cleansing, the interior surface of the whole system will coat over with a greasy slime, known to give off pestiferous gases ten times more abominable than those found in the main sewer.

Ventilation, while indispensable as a diluter and safe remover of any gases forming or collecting in the system, tends furthermore to arrest, and to a great extent destroy, such a coating. The free ventilation of the whole system, therefore, demands our most careful consideration. This brings up a point still at issue among leading sanitary authorities:—"The whether a tray should be placed on the house drain before it empties into the street sewer, or not." I am inclined to side with those who hold that, while there may be some doubt as to the policy of omitting such a trap in cities, for instance like Toronto, where in the first place the main sewers have been ill constructed, and still more badly ventilated; that, even in the case of only tolerably good sewers, such arguments are only valid that advocate the omission of such traps. It is a fact that such traps arrest the flow of the waste liquids along the pipes, and therefore destroy in a measure their scouring properties, besides reducing the efficiency of carriage of the said liquids.

They also tend to complicate the system by rendering it necessary to introduce a fresh air inlet pipe, on the house side of their water seals, in order to provide for ventilation.

At the b[illegible]t, this additional pipe, when brought a few feet above the ground, certainly does not add to the artistic effect of a building, and may sometimes prove dangerous to children who may be playing in its vicinity. For since we have the pressure of this obstructing trap on the one side, and sometimes a descending column of water in the soil on the other, any gases thus confined between the two, can only escape by this so called "fresh-air inlet pipe."

Besides, I feel fully convinced that the best and most uniform ventilation for our lines of pipes and drains can only be secured when we open one end into the larger street sewer beneath the ground, and the other towards the starry firmament above the roof.

That every part of the plumbing be visible, whenever possible, and conveniently situated as against accidents and repairs.

It is not long since you could not find a single fixture in even the most costly of dwellings, that was not tightly cased in wood. This was particularly so with the water closet. Sanitarians pointed out the dangers to health arising from such a practice, and to-day one can judge of the general improved tone of public opinion on the matter, by just simply looking though any of the numerous descriptive catalogues issued by manufacturers of plumbing fixtures, etc., who, of course, study the demands of the market.

The public taste is certainly tending in the right direction, when marble topped wash basins, supported merely by open brackets or brass legs, and water closets free from all woodwork save for an oak or mahogany top, are being introduced into the better class of dwellings.

Still we find that certain parts of our system, just as important to the efficient working of the whole, but because of less pretentious appearance than the wash basin and water closets, often seem to have been sadly neglected in the apportionment of the plumbing expenditures. I refer to the all important kitchen *sink*, and servants' hopper.

One often finds that while care and judgment are manifest in the selection and arrangements of the other fixtures of a house, any cheap concern has been accepted to pass for the kitchen sink. But, as if instigated by some secret feeling of doubt as to the justifiableness of such a course, and as if ashamed of the uncanny result, we find that the owner, or architect, has had it securely encased in carpentry.

Not only are the waste pipes, traps, and joints thus cut off from view where they most require watching, but as the dark foul space underneath the sink is invariably utilized for the storage of cooking utensils, mops, rags, old shoes, coal oil cans, scrubbing brushes, boot blackening, grease, and other matter certainly never calculated to aid sanitary conditions.

The same might be said of the servants' hopper, which should be free from all wood work.

It should be placed where a quantity of light and ventilation can be had at all times, and not carefully and gingerly confined to a little cubby hole somewhere beneath the staircase, or in a dark unventilated closet, where it works mysteriously in a mysterious darkness.

A word with regard to the soil pipe in the basement. The best practice of the day is justly tending to do away with the burying of the soil pipe within the house, and underneath the concrete or wooden flooring of the cellar. That this was a pernicious habit it is needless to explain.

Should an obstruction of any kind take place within the house, it might necessitate the tearing up of yards and yards of flooring. And then again, a line of pipes so placed could not be tested and examined as effectually as if raised clear of the floor, and open to view, leaks and other imperfections announcing their presence, and being detected much more readily, in the latter case.

That all parts be of sound material, free from flaws, blemishes, or other defects and of the kind of material best suited for their special purpose.

In the last few years wrought iron has been introduced in the plumbing of buildings, under what is known as the "Durham system of house drainage."

The great advantages claimed by Mr. Durham, a civil engineer, for his system are that "wrought iron pipes are elastic and cannot be broken, and that when lengths are screwed together in a wrought iron coupling, the joint is as strong as any other part of the pipe; furthermore, they will stand up vertically from a solid base to the height of any building without lateral support, and being much lighter are more easy to handle."

Mr. Durham goes on to say:

"By the use of wrought iron pipes and screw-joints we construct a drainage apparatus within the building, which is gas and water tight as regards the joints; rigid, yet elastic: entirely independent of walls or floors for support, and absolutely invulnerable. As a structure it will last as long as any building will stand, and without any outlay for repairs." The thorough reliability of screw joints, and the uniformity of thickness and strength which can only be secured by the use of wrought iron soil pipes, seem to be the chief points in favour of this system.

Cast iron pipes, when of sufficient thickness, make good soil pipes. This is easily determined by their weight, and the only quality, known on the market as "extra heavy," can be safely recommended.

Even this class of pipe sometimes displays a marked unevenness of thickness on the opposite sides of a cross section, and therefore being in its weakest part no better than light pipe.

The bells on the "extra heavy" have sufficient strength to stand the caulking necessary to insure a trustworthy joint, which is not the case with the lighter class of pipes.

Lead is of course unfit for soil pipes, and should not be used even for waste pipes when a diameter of over two inches is required. For smaller waste and vent pipes, lead can be used to great advantage, for it bends, cuts, and manipulates easily.

The thickness of any lead pipe, or in other words the weight per running foot, should always be determined with reference to the work it is intended to perform.

Cast lead traps are objectionable, drawn lead being preferable for that purpose.

Traps and pipes made by hand of sheet lead are of course out of date.

Brass is also used in ferrules and in the best forms of traps. It is also used, either polished or nickle plated, for those portions of the plumbing system that lie exposed in connection with the better class of fixtures.

Cast brass traps, are among the very best and most efficient, and to my mind a great improvement on lead traps.

Glass, when used as a portion of a trap, is objectionable, as it is so liable to break by a number of causes.

With regard to the fixtures of this system, I might say that the water closet should be of earthenware or porcelain ware, in one piece, and connected to the soil pipe by the brass flange method. Any of the washout closets are good, though the more recent siphon closets, as for instance the Sanitas, and also such improved hopper closets as the "Trent wash down," are considerably better. For the respective advantages of these I must refer you to works on the subject. Baths and basins should be of porcelain ware. When a bath of this kind should be found too expensive, a "porcelain-lined iron bath" of the Imperial class will answer well; and hoppers and kitchen sinks should be preferably of English brown ware, or Yorkshire ware. Porcelain-lined wash tubs are good, though they do not last like the porcelain ones.

That the whole system be put tightly together in the best approved manner, and possessing uniformity in strength and durability.

This comprises a very wide and important field, for, not only must the mechanical part, *i. e.*, the cutting, bending, fitting, wiping, soldering, caulking, etc. (which go to make the Art as distinct from the Science of plumbing), come under consideration singly; but the whole work must be previously thought out, with a view to uniformity of strength and durability of the entire system. While the most approved practical methods may be understood by the scientist, it takes the practical workman to carry them out in part or in whole, and for this fact a good mechanic is indispensable. For the tightness and safety, then, of our system, we have to depend on the mechanical ability of the men we employ. No matter how scientific and commendable our plans, if the workmanship prove below the mark, miserable or defective, we must expect to meet with disappointment or failure. I therefore fail to see the force of the arguments seemingly based on the

* Lecture delivered before the Engineering Society of the School of Practical Science, Toronto.

assumption that the science is everything, and the art a very secondary portion of our subject.

That this was the tendency among sanitarians in Great Britain, when sanitary plumbing received a fresh impetus some ten years ago, may be seen from the following remarks by S. Stevens Aellyer :

"If I were going to build a house for my own occupation, I should prefer the plumbing work to be done by the man who was more skilled in the science than in the art of his craft—that is to say, I should prefer a poor joint wiper to a clever one, providing the former knew what the latter did not, viz., how to select and arrange the trap, pipes, and fittings, so that they would be 'self-cleansing'; what kind of traps to select, and how to ventilate them so that they would not lose their water seals, how to ventilate the waste-pipes, soil pipes, and drains, so that the air within them should be constantly changed—know, in short, how to execute his work on sanitary principles."

In these days of *specializing* and *high speed*, it would almost be impossible to find a man who might be considered equally competent to lay out both a system of plumbing for you, and construct the same from cellar to attic with his own hands. We do not expect it. We do not want it. But we do insist on the joints being well wiped, the bends properly made, and the bells tightly caulked.

That the whole system be as simple as possible and consistent with convenience, efficiency, and security.

I think this appeals to all scientific minds, though I know of certain plumbers in this town, who, if judged by their works, certainly could not be said to agree with me in this respect.

However, I am glad to notice that there is a strong tendency towards simplification in plumbing work throughout this continent, which will tend to make good plumbing more popular and less costly, and I firmly believe that a judicious use of anti-siphonic traps will prove one of the greatest factors in simplifying the house-plumbing of the future.

While I do not admit that they are preferable in *every* case, and for *all* fixtures, still I will say this, that the better kinds are more trustworthy, and less liable to get out of order than architects and sanitarians imagine, and further, that for certain cases they are undoubtedly the only traps that meet the requirements to any degree.

Owners should be advised against such fads as, for instance, having a basin, or other fixture, placed in some remote corner of the house, and at a considerable distance from any of the main pipes of the plumbing system. Such arrangements greatly increase the number and complication of pipes, not to speak of the cost, and the fact that security is being sacrificed, in a measure, for trifling convenience.

At present the vent-holes in water closet fixtures are made too small. A water closet trap should be vented with nothing less than a 3-in. vent pipe, and running traps under basins, etc., should be vented with vent-pipes at least of the same size as their wastes, and in most cases a little larger diameter is preferable.

Sanitarians seem to forget that while ventilating pipes are useful in preventing the siphoning of traps, their principal work is to ventilate. Experiments have shown that they cannot do this *effectively*, unless they are made large enough.

As sink wastes have a tendency to be too large, we may therefore expect to see, in the near future, the diminution of the diameter of certain wastes, and the enlarging of certain ventilating pipes, and thereby the increasing of the efficiency of both.

That the appliances used be economical, reliable, and adding materially to the comforts of the inmates of the building.

In conclusion, I may say that the number of fixtures in a dwelling should be kept down as much as possible. Not merely from a consideration of economy, but from the more important standpoint of health. The oftener traps are used the better. Where a house has a large number of basins, some may be rarely used, and their traps are liable to evaporate away. Wherever overflow-pipes can be done away with, it is for the better.

Basins provided with the Boston plug, which acts both as a plug and as an overflow waste in itself, are the best fixtures of the kind on the market to-day. Wastes from refrigerators, cistern, safes, etc., of course should never be connected directly to the plumbing system, but all these secondary points are well treated in any of the more recent books on the subject.

After all, the underlying principle of "sanitary plumbing," is to secure such an arrangement of pipes, traps, and fixtures, that any solids, liquids, or gases can readily and speedily find an entrance into the plumbing system, at any of the openings in the house; but that having once gained an entrance, they can never-more return to injure the health of the inmates of that dwelling. When this fundamental principle is thoroughly understood, it should not prove a hard task to determine upon a sanitary system of house drainage.

The Hobbs Hardware Company, London, Ont., will start a bevelling, silvering and plating factory.

Mr. E. R. Burpee, is at the head of a company which proposes to establish granite polishing works at Calais, N. B.

Mr. Peter Nicholson, one of the oldest contractors of the city of Montreal, died on May 3rd from injuries caused by a runaway horse. Deceased, who was seventy-one years of age, was a native of Castleton, Caithness, Scotland. He was a resident of Montreal for thirty-four years.

MANUFACTURES AND MATERIALS

HYDRAULIC CEMENTS—NATURAL AND ARTIFICIAL, THEIR COMPARATIVE VALUES.*

(Continued from April Number.)

The Board of Public Works, or the city engineer advertises for cement. The specifications call for a certain fineness, and so many pounds tensile strain—1 hour in air and 23 in water.

Then up comes the great unwashed army of cement-makers, who, unlike the engineers that sit in judgment over their hard-wrought products, have not yet awakened to the wondrous advantages of association, having no "A. S. C. E." (American Society of Cement Experts), through which to elevate their calling to the dignity and standing it deserves. And so they scramble up to the engineer's office each with his pockets filled with testimonials proving his cement to be the best manufactured in the United States.

And what of the engineer? We notice a peculiar gleam in his eye, that we never observed before. Serenely he surveys the group of uneasy cement-makers before him. He opens the bids, and as usual, the figures are all bunched closely together. The cement-makers are anxious. Not so with the engineer, for with a sardonic smile he vouchsafes the blood-curdling information, that the board had ordered a testing machine.

In the course of time it is announced that the contract has been awarded to Mr. A., as his cement stood the highest in the test. Then another city advertises, and the same operation is repeated, and B gets the contract, because his cement stood the highest in the test. And so with one city after another, and the cement-makers from A. to Z. all get a chance, and all are satisfied, for each has found a place where his cement has tested the highest, thus proving conclusively that each brand was the best.

In our search for the key, with which to unlock the door of discovery of the connecting link, that as we have said ought to exist between high tensile strain and first quality, we have traveled up and down the whole line, commencing with cement containing 50 per cent. clay and 50 per cent. lime, and following along up through its varying mixtures until pure white lime with no clay is reached.

These we have studied under every conceivable manner of manufacture and subsequent manipulation. Studying the varying properties, with all their bewildering and mystifying contradictions; plodding through the thousand and one phrases that are continually being developed in the course of a long experience in the study of the natural cements of this country, no two brands of which are alike in their proportions of lime, magnesia, silica and alumnia; searching the tables of tests made by prominent engineers from time to time; comparing the tables with the analyses of the brands tested; weighing carefully every feature that gave the slightest promise of throwing light on the subject; and now, after all these years, we are compelled to admit that we have not been able to discover the slightest relationship between the high test and good quality. We cannot tell what the future may have in store for us. Some genius who may not have devoted more than his spare moments to the subject, may tell us all about it.

Practical experience teaches that we can find both good and bad cements that will sustain a high tensile strain, and that we can find both good and bad cements that will test low.

Portland cement has not been in use in this country long enough to earn the position it now occupies, but owing to some peculiarity in its molecular construction, it will test higher than our American cements and will get harder. Yet hardness is no evidence of durability; with equal exposure, a flint stone will disintegrade much more rapidly than a soft magnesian lime stone.

But the demand is for a higher testing cement, and the engineer who years ago, used American cements in a sewer or bridge, without a thought of failure and with no signs of failure yet in sight, will incline to the belief that he ought to use a better cement, and so Portland is used in what are called trying places. But the fact that he once used American cements successfully in places just as trying, is dismissed, for he does not care to take any chances of that kind again, and so public opinion has been built up, and it would be a rash man indeed who would dare to stand up against it.

Even the manufacturer of a first-class American cement, who may have grown grey in the business, looking back over the field, calls to mind the work done with his cement. Here is a costly bridge with its piers reaching far down below the surface. There is a tunnel running through the base of a mountain. He recalls the great bridges over the Niagara, the water works tunnel under Lake Michigan at Chicago; the great bridges spanning the Ohio, Mississippi and Missouri; the thousands of miles of railroads with their innumerable culverts and bridges; the sewers in all the cities of the country, amounting in the aggregate to hundreds upon hundreds of miles. With all these marvelous engineering works of the past to look upon, consuming upwards of seventy-five million barrels of natural cement—all manufactured in this country, and none of these works requiring renewal on account of the poor quality of the cement used, yet the manufacturers of this enormous amount of cement are daily reminded that their cement is an article, good enough perhaps of its class, but it is only a common cement at the best.

(To be Continued.)

*Extracts from a Paper read before the Society of Arts of the Massachusetts Institute of Technology, Boston, Mass., by Mr. W. Cummings, of Buffalo, N. Y.